Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.6757

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (5):** 985-989 (2018)

Research Article

OPEN ACCESS

Morpho-Physiological Characterization of Rabi Sorghum (*Sorghum bicolor* L.) Genotypes for Drought Adaptive Traits under Medium Soils

Kiran, B. O.*, S. S. Karabhantanal, I. S. Katageri and M. B. Boranayaka**

[*]Scientist (Physiology), [**] Scientist (Entomology) AICRP on Sorghum Improvement, Regional Agricultural Research Station, Vijayapur, University of Agricultural Sciences, Dharwad-580005

*Corresponding Author E-mail: kiranbo@uasd.in

Received: 1.08.2018 | Revised: 30.08.2018 | Accepted: 7.09.2018

ABSTRACT

Sorghum (Sorghum bicolor L. Moench) is one of the five major cereals in the world. It is generally considered to be more drought tolerant than maize and is often cropped under rainfall conditions. This study was conducted to identify superior drought adaptive sorghum genotypes under medium soils which include thirteen lines with three checks (M 35-1, P. Suchitra and P. Anuradha). The biomass and leaf area was significantly higher in BJV 125 (119 g plant^{-1} and 1587 cm^2 plant^{-1}) at 50% flowering compared to checks. However, RSV-1822, CRS-68 and BJV-371 recorded higher LAI (2.070, 2.217 and 2.017, respectively). The SPAD values and relative water content in leaf was maximum in BJV 125 (52.54 and 83.55%, respectively) followed by BJV 371 (46.33 and 83.66%). The total chlorophyll content was significantly higher in P. Anuradha and RSV 1822 (2.486 and 2.367 mg g^{-1} fr. wt.) at 50 % flowering. Further, the results on yield and associated traits indicated that, test weight and harvest index was significantly higher in CRS-67 (45.13 g and 46.55, respectively) followed by BJV 371 (40.63 g and 47.13, respectively). Similarly, grains per panicle and grain yield was higher in BJV-371 (2446 and 3085 kg ha^{-1}) followed by BJV-129 (2357 and 2938 kg ha^{-1}). The experiment inferred that, genotype BJV 371 and BJV 129 were found more adaptive to drought condition and may provide better source for breeding/developing heat tolerant genotypes in rabi sorghum

Key words: *Test weight, Relative water content, Chlorophyll, Harvest index, Grain yield*

INTRODUCTION

Sorghum (*Sorghum bicolor* L.) is one of the major cereal crops of India after rice (*Oryza sativa* L.) and wheat (*Triticum aestivum* L.). The crop is primarily grown in Maharashtra, Karnataka and Andhra Pradesh. These three states together account for 80 per cent of the all India production. Madhya Pradesh, Gujarat and Rajasthan are the other states where sorghum is produced. India is the third largest producer of sorghum in the world with an area of 5.30 million hectare and production of 5.05 million tons and the productivity is 953 kg/ha.

Cite this article: Kiran, B.O., Karabhantanal, S.S., Katageri, I.S. and Boranayaka, M.B., Morpho-Physiological Characterization of Rabi Sorghum (*Sorghum bicolor* L.) Genotypes for Drought Adaptive Traits under Medium Soils, *Int. J. Pure App. Biosci.* **6(5):** 985-989 (2018). doi: http://dx.doi.org/10.18782/2320-7051.6757

In Karnataka the area under sorghum is 1.06 million hectare, with the production of 1.22 million tons and the productivity is 1,154 kg per ha. Sorghum is also grown in tropical and sub-tropical areas of Africa and Asia, mainly for human consumption. Characterization of sorghum for food, fodder, quality and ethanol is being accepted to different agro-ecological situations in Karnataka. However, for *rabi* season is characterized by terminal drought, low temperatures and biotic stresses like shoot fly infestation which are the major constraints for higher productivity[6]. Currently, the ruling genotype M 35-1 covers over 70 percent of northern Karnataka because of its wide adaptability and roti making quality. Even though hundreds of crosses have been made, none of them sustain with respective to quality, biotic and abiotic factors. Therefore, there is a need for the development of varieties adapted to specific soil situation in *rabi* season to enhance production and productivity levels[8]. Hence, the present aim of the study is to evaluate the promising and M 35-1 derived lines for better adaptive traits based on physiological features.

MATERIAL AND METHODS

The present field experiment was conducted during *rabi* 2017-18 at Regional Agricultural Research Station, Vijayapur, which is situated at 1649' N latitude and 7543'E longitude with an altitude of 593m above main sea level. The experimental site consisted of medium black soil. 13 promising sorghum lines were used to evaluate for drought adaptive traits with three checks (M 35-1, P. Suchitra and P. Anuradha). crop was raised with a spacing of 45×15 cm2, fertilized with 50:20:0 $N:P_2O_5:K_2O$. The maximum and minimum temperature along with rainfall and humidity was recorded from the Agrometeorology Station, Vijayapur (Figure 1) during the crop growth phase. The observation on SPAD values, relative water content, total chlorophyll content in leaves were recorded at 50 percent flowering and yield and associated traits such as seeds per panicle, harvest index, test weight were recorded at harvest.

RESULTS AND DISCUSSION

The analysis of variance showed that, growth parameters differed significantly among the genotypes. Among the genotypes tested for drought adaptive traits under medium soil, genotype RSV 2138 recorded significantly maximum plant height (234 cm) compared to M 35-1 (208cm). In sorghum, plant height is highly correlated with biomass yield[10,5,2]. Plant height is controlled primarily by maturity and internode length. The longer sorghum plant remains vegetative, the greater the number of leaves and nodes that it makes. Hence, late-flowering plants are generally taller than early-flowering plants. The transition from the vegetative to the reproductive phase is controlled by Maturity (Ma) genes that respond to variation in photoperiod[4]. Days to 50 % flowering and physiological maturity was significantly lower in genotypes P. Anuradha (69.33 and 102.67 days respectively) followed by RSV-2121 (70.33 days) and RS-65 (112.67 days). However, genotype BJV-371 recorded significantly maximum days to 50 % flowering and physiological maturity (82.00 and 125.33 days respectively)[7]. reported that, matching duration of the crop cycle for drought adaptation *via* genotypically in phenology is one of the most obvious means of drought escape. Early flowering generally results in higher grain yield and greater stability compared to late flowering in sorghum. The results showed that, the soil water status has a greater influence on the biomass partitioning among the genotypes. Decrease in soil moisture resulted in lower portioning efficiency. Genotypes BJV-362 and BJV-371 recorded higher biomass (93.43 and 95.45 g plant^{-1}) at 50 % flowering. However at physiological maturity genotype BJV-125 recorded significantly higher (199.05 g plant^{-1}) followed by BJV-129 (190.88 g plant^{-1}) which was comparatively higher that of check M 35-1 (140.95 g plant^{-1}) and P. Suchitra (149.55 g plant^{-1}). Further genotypes BJV-125 and RSV-362 recorded maximum leaf area (1587 and 1323 cm^2 plant^{-1}) compared to M 35-1 and P. Anuradha. Leaf area index was significantly higher in CRS-68 (2.217) followed by RSV-

1822 (2.070) and M 35-1 (2.057). Increased leaf surface results in increased reflectance which lowers leaf temperature, leaf air vapour pressure and water loss contributing to the grain yield[3]. The physiological traits such as SPAD values, relative water content of leaf tissue and total chlorophyll content indicated the efficacy of the genotype for better adaptation. Overall, the sorghum lines significantly maintained chlorophyll contents. Xu *et al.*[11], investigated that, sorghum genotypes with and without post-flowering drought tolerance (*i.e*. "stay green") differed with chlorophyll content. In the drought-tolerant genotype, these researchers reported a 23% reduction in total chlorophyll content between stressed and non-stressed plants; while a 75% reduction was found in the non-"stay green" genotype. In our study, at 50% flowering the SPAD values were significantly higher in genotype RSV-2138 (52.44) followed by BJV 125 (52.54). However, genotype P. Anuradha recorded significantly higher total chlorophyll content (2.486 mg g^{-1}fr. wt.) followed by genotype 1736 (2.367 mg g^{-1}fr. wt.) and RSV 1919 (2.300 mg g^{-1}fr. wt.). The leaf water content is a measure of plant stress and severe decreases may contribute to structural interruptions of important biological functions in plants leading to injury or tissue death. The relative water status was recorded maximum in BJV-129 (83.55%) followed by BJV 371 (83.66%) which was comparatively higher than M 35-1 (82.56%) and P. Suchitra (75.88%). Tolerant plant maintain cell turgor and cell volume their by avoiding the water deficit in tissue. Dehydration avoidance can be achieved by the maintaining water uptake, reduced water lose, osmotic adjustment and increased tissue elasticity[1]. The data on yield and yield components differed significantly with genotypes. P. Suchitra (2486 $plant^{-1}$) recorded significantly higher grains per panicle followed by BJV 129 (2357 $plant^{-1}$). However, test weight was significantly higher in CRS 67 (45.13 g) followed by BJV 371 (40.63 g). The harvest index was significantly influenced by the partitioning efficiency and soil moisture levels. Grain yield was significantly higher in BJV 371 (3085 kg ha^{-1}) followed by BJV 129 (2938 kg ha^{-1}) which was comparatively higher than M 35-1 (2677 kg ha^{-1}) and P. Suchitra (2803 kg ha^{-1}). However, the harvest index was maximum in BJV 371 (47.13) followed by CRS 67 (46.55)[9]. reported that drought resistant sorghum lines accumulated higher levels of proline, maintains chlorophyll content and relative water content in tissue compared with drought susceptible lines. Therefore, in the present study genotypes BJV 371 and BJV 129 were found better adaptive to drought under medium soils compared to other genotypes. However, genotypes BJV 125 recorded high biomass with leaf area.

Table 1. Morpho-Physiological parameters of rabi sorghum genotypes for drought adaptation traits in medium soil

Sl. No	Genotypes	Plant height (cm)	D50F (Days)	Days to Maturity (days)	Total biomass @50%F (g/plant)	Total biomass at maturity (g/ plant)	Leaf Area (cm^2/plt)	Leaf area index (LAI) at 50% F
1	RSV 1736	216	74.00	116.67	72.71	143.08	1162	1.623
2	RSV 1822	221	82.00	124.00	73.71	130.79	1319	2.070
3	RSV 1910	215	80.00	121.33	76.76	123.21	1371	1.937
4	RSV 2121	221	70.33	115.67	85.38	147.94	1037	1.780
5	RSV 2138	234	74.33	118.33	85.86	155.42	1142	1.650
6	CRS 65	203	72.33	112.67	64.61	166.35	1104	1.370
7	CRS 66	205	72.33	117.00	64.97	130.15	1062	1.420
8	CRS 67	219	73.00	118.00	62.26	122.94	1021	1.653
9	CRS 68	201	75.67	124.00	67.08	140.46	1096	2.217
10	BJV 125	221	76.33	124.00	70.36	199.05	1587	1.800
11	BJV 129	228	79.33	118.33	76.65	190.88	1323	1.967
12	BJV 362	224	80.00	117.67	93.43	153.73	1260	1.500
13	BJV 371	225	82.00	125.33	95.45	145.75	1189	2.017
14	M-35-1 (C)	208	75.33	121.00	82.56	140.95	1081	2.057
15	*P. Suchitra* (C)	204	73.00	124.00	81.22	149.55	1113	1.423
16	*P.Anuradha* (C)	194	69.33	110.67	68.32	123.37	1216	1.463
	S.Em. ±	**6.884**	**0.926**	**1.094**	**3.18**	**6.45**	**105.81**	**0.100**
	CD @5%	**11.916**	**1.603**	**1.894**	**5.50**	**11.17**	**183.15**	**0.173**

Table 2. Yield and yield associated traits of rabi sorghum genotypes for drought adaptation traits in medium soil

Sl. No	Genotypes	SPAD value @50%F	RWC % @50%F	Total Chl. @F (mg/ g fr wt)	Grain number (Panicle^{-1})	Test weight (g)	Harvest Index (%)	Grain yield (kg/ha)
1	RSV 1736	49.58	81.35	1.960	1668	34.46	40.838	2228
2	RSV 1822	50.70	77.10	2.367	1070	36.73	27.286	2794
3	RSV 1910	49.71	76.90	2.300	1324	35.87	37.682	1951
4	RSV 2121	50.76	80.52	2.325	1801	33.80	39.757	1744
5	RSV 2138	52.44	81.00	2.265	1698	36.26	44.678	2177
6	CRS 65	42.16	81.90	2.133	1516	34.13	33.530	1890
7	CRS 66	51.85	74.49	2.134	826	35.54	25.476	2330
8	CRS 67	49.06	78.32	2.066	1525	45.13	46.553	2609
9	CRS 68	48.37	82.67	1.982	1718	35.28	46.411	2006
10	BJV 125	52.54	83.25	2.188	1557	35.57	27.893	2041
11	BJV 129	51.54	83.55	2.099	2357	33.96	42.496	2938
12	BJV 362	51.23	82.99	2.032	2025	30.13	38.263	2753
13	BJV 371	46.33	83.66	1.858	1523	40.63	47.132	3085
14	M-35-1 (C)	49.21	82.56	2.215	1766	36.40	45.986	2677
15	*P. Suchitra* (C)	51.35	75.88	2.363	2446	36.60	46.135	2803
16	*P.Anuradha* (C)	48.52	78.76	2.486	1403	39.20	40.897	1696
	S.Em. ±	**1.52**	**1.63**	**0.128**	**74.44**	**3.34**	**2.26**	**161**
	CD @5%	**2.64**	**2.82**	**0.221**	**128.86**	**5.79**	**3.92**	**279**

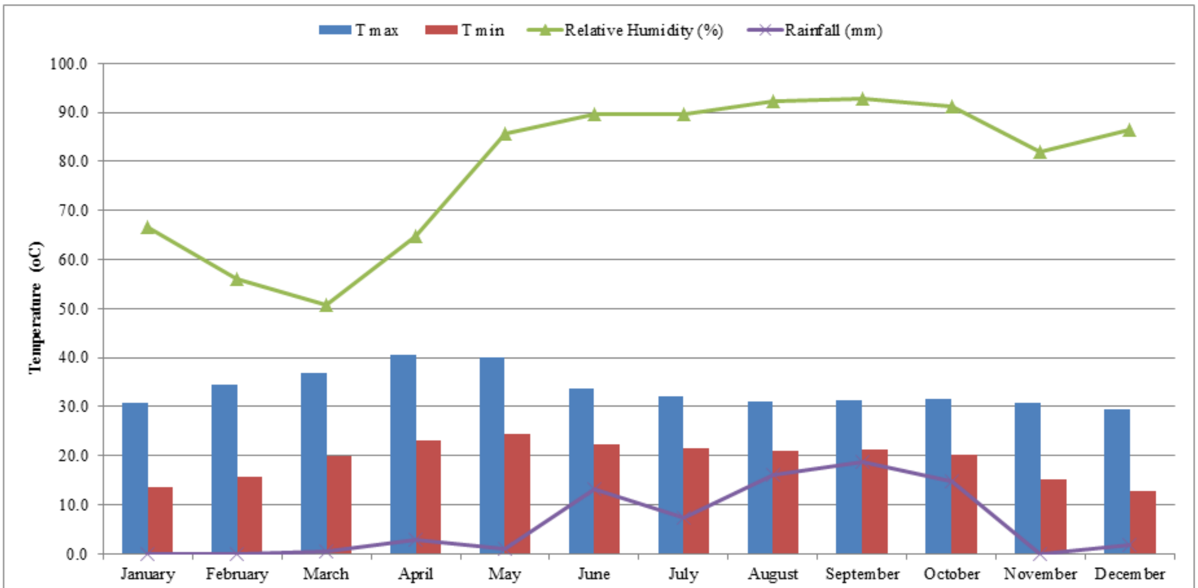

Fig.1 Monthly Fluchuations of temperature (T max and T min) 2017 during the crop period of Sorghum

CONCLUSIONS

The present study examined the adaptability of the elite sorghum line to drought based on the physiological characteristics under medium soils. Genotypes BJV 371 and BJV 129 recorded superior yield levels compared to check M 35-1 and P. Anuradha. Although all genotypes recorded significantly higher chlorophyll and maintained relatively higher tissue water status, genotypes BJV 371 and BJV 129 were found greater adaptability to drought based on physiological characters. Further, Molecular investigations to elucidate a full profile of possible drought-responsive mechanisms in selected sorghum genotypes is to be marked.

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